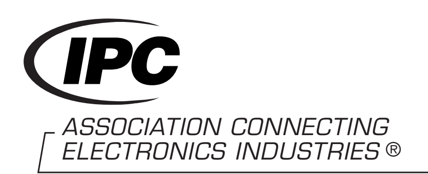


IPC-2583

Sectional Requirements for Implementation of Design Characteristics for Manufacturing Data Description



Endorsed by the International Electronics Manuafacturing Initiative (iNEMI)

IPC-2583

May 2007

A standard developed by IPC

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- Contain simple (simplified) language
- Just include spec information
- Focus on end product performance
- Include a feedback system on use and problems for future improvement

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- Increase time-to-market
- Keep people out
- Increase cycle time
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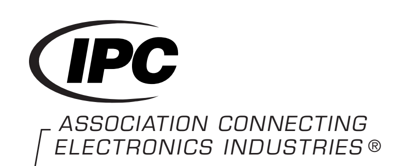
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IPC-2583

Sectional Requirements for Implementation of Design Characteristics for Manufacturing Data Description

Developed by the CAD/CAM Convergence Subcommittee (2-17) of the Data Generation and Transfer Committee (2-10) of IPC

Users of this publication are encouraged to participate in the development of future revisions.

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Acknowledgment

Any document involving a complex technology draws material from a vast number of sources. While the principal members of the CAD/CAM Convergence Subcommittee (2-17) of the Data Generation and Transfer Committee (2-10) are shown below, it is not possible to include all of those who assisted in the evolution of this standard. To each of them, the members of the IPC extend their gratitude.

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Sectional Requirements for Implementation of Design Characteristics for Manufacturing Data Description

INTRODUCTION

This standard is part of the IPC-2580 series of standards. These standards specify a data file format used to describe printed board and printed board assembly products with details sufficient for tooling, manufacturing, assembly, inspection and testing requirements. The format may be used for transmitting information between a printed board designer and a manufacturing or assembly facility. The files are also useful when the manufacturing cycle includes computer-aided processes and numerical control machines.

The IPC-2580 format requirements are provided in a series of standards focused on design printed board fabrication, assembly, inspection, and testing. This standard series consists of a generic standard (IPC-2581) which contains all the general requirements. There are seven sectionals that are focused on the details necessary to accumulate information in a single file that addresses the needs of the manufacturing disciplines producing a particular product.

The sectional standards (IPC-2582 through 2588) paraphrase the important detailed requirements and provide suggested usage and examples for the topic covered by the sectional standard. The information can be used for both manual and for digital interpretations. The data is defined in either English or International System of Units (SI) units.

1 SCOPE

This standard (IPC-2583) provides the information on design characteristic features intended to define the basic principles used for indicating how to document the manufacturing requirements and any special symbology needed in the data description hierarchy. Since the requirements are important to every file in order to understand the file usage, the XML schema is reused in every Business to Business transaction. This standard calls out the details defined in the generic standard (IPC-2581) that are required to accomplish these focused tasks.

1.1 Intent

The IPC-2581 contains all the requirements necessary to build an electronic product. The cardinality indicated in the IPC-2581 may be superseded by a restriction of an attribute (enumerated string ID) or indication of a requirement that is noted as being optional in the generic standard, however this standard makes the requirement mandatory based on the supply chain communication need.

In order to assist the users of this standard, all the applicable XML schema elements that apply to the Design Characteristics and Documentation Function are listed in Appendix A. The list is grouped by topics and shows the Absolute Path for the elements that pertain to the focus of this standard. If the Parent element is not present no children are to be considered in the implementation, however all Attributes identified for a particular element **shall** follow the cardinality of the IPC-2581 unless a restriction is stated in this standard.

1.2 Interpretation

"**Shall**", the emphatic form of the verb, is used throughout this standard whenever a requirement is intended to express a provision that is mandatory. Deviation from a **shall** requirement is not permitted, and compliance testing is required in order to demonstrate that the XML instances are correct according to the W3C directives and this standard. The XML schema **shall** be the method to check syntax and semantics. Any appropriate software tool that prompts the user, to correct the ambiguity or to insert missing information, may be used for this purpose.

The words "should" and "may" are used whenever it is necessary to express non-mandatory provisions.

"Will" is used to express a declaration of purpose.

To assist the reader, the word **shall** is presented in bold characters

2 APPLICABLE DOCUMENTS

The following documents contain requirements which, when referenced, constitutes provisions of IPC-2583. The IPC-2583 represents an electronic representation of the documentation standards identified by the IPC-2610 series (i.e., IPC-2611, IPC-2613, IPC-2614 etc.) At the time of publication, the editions indicated were valid. All documents are subject to revision and parties entering into agreements based on this standard are encouraged to investigate the possibility of applying the most recent additions of the documents indicated below.

The revision of the document in effect at the time of solicitation **shall** take precedence.

IPC-T-50 *Terms and Definitions for Interconnecting and Packaging Electronic Circuits.*

IPC-2581 *Generic Requirements for Printed Board Assembly Products Manufacturing Description Data and Transfer Methodology*

IPC-2582 *Sectional Requirements for Implementation of Administrative Methods for Manufacturing Data Description*

IPC-2589 *Sectional Requirements - Activity Model for Printed Board Assembly Products Manufacturing*

IPC-2611 *Generic Requirements for Electronic Product Documentation*

IPC-2613 *Sectional Requirements for Assembly Documentation (Electronic Printed Board and Module Assembly Descriptions)*

IPC-2614 *Sectional Requirements for Board Fabrication Documentation (Printed Circuit board Description Including Embedded Passives)*

3 REQUIREMENTS

The requirements of IPC-2581 are a mandatory part of this standard. That document describes the generic requirements for the converged GenCAM and ODB++ formats. The generic details specifically provide data related to design, printed board manufacturing, assembly and test.

The XML schema of the 2581 consists of six major Elements each of which have several children who then become new parent elements. Several of these major elements and their associated new parents are defined in other sectionals. The requirements of IPC-2582 are also a mandatory part of the parts list product data description standard to the extent of their description and any restrictions contained in this standard.

Each of the standards and the elements defined therein has a specific function or task respectively, and although they may at times be used independently, they become an important addition to the requirements of the board fabrication descriptions. As such the following paragraphs provide the total requirements for the three types of board fabrication files that are supported by the principles of the IPC-2581.

Accordingly, the information interchange for the specific purpose of printed board fabrication is only possible if all the XML instances have been properly prepared for such a purpose.

3.1 Terms and Definitions

The definition of all terms **shall** be in accordance with IPC-T-50 and the following. A term number at the end of a line indicates that it is a reproduction from IPC-T-50 to assist the reader in interpretation of this standard.

3.1.1 Datum 22.0344

The theoretically-exact point, axis or plane that is the origin from which the location of geometric characteristics of features of a part are established.

3.1.2 Datum Target 22.1668

A specified point or area on a printed board used to establish a datum.

3.1.3 Design Rule 22.0363

Guidelines that determine automatic conductor routing behavior with respect to specified design parameters.

3.1.4 Fiducial (Mark) 22.0493

A printed board feature (or features) that is (are) created in the same process as the conductive pattern and that provides a common measurable point for component mounting with respect to a land pattern or land patterns.

3.1.5 Grid 22.1812

An orthogonal network of two sets of parallel equidistant lines that is used for locating points on a printed board.

3.1.6 Land Pattern 22.0678

A combination of lands that is used for the mounting, interconnection and testing of a particular component.

3.1.7 Least Material Condition (LMC) 22.0701

The condition in which a feature of size contains the least amount of material within the stated limits of size.

3.1.8 Maximum Material Condition (MMC) 22.0747

The condition in which a feature of a certain size contains the maximuml amount of material within the stated limits of size.

3.2 Categories and Content

Table 3-1 provides the major functions that **shall** be addressed by the 2582 standard. The descriptions relate to the appropriate information needed by most of the sectional standards. There are four (4) unique functions that can be defined by the use of the XML elements and the resulting XML instances. Each of the functions has additional child elements that may or may not be present as determined by the purpose of the data file, the maturity of the file, and the supply chain business transaction usage.

Table 3-1 indicates the relationships of the requirements for various elements and topics within the descriptions for a particular process. The letter **"M"** signifies a *mandatory* requirement. The letter **"O"** signifies an *optional* characteristic that may or may not be pertinent to the particular file or data interchange. A dash signifies an extraneous section (unnecessary); although software tools used to parse the file will permit the extraneous data, it is recommended that only the requirements identified as mandatory or optional are included in the file in order to reduce file size transfer.

Table 3-1 File Segmentation and Functional Requirements

Name	Full	Design			Fabrication			Assembly			Test		
		1	2	3	1	2	3	1	2	3	1	2	3
Content Elements	M	M	M	M	M	M	M	M	M	M	M	M	M
Logistic Header Elements	M	M	M	M	M	M	M	M	M	M	M	M	M
History Record Elements	M	O	M	M	O	M	M	O	M	M	O	M	M
Documentation Layers	M	O	M	M	O	M	M	O	M	M	O	O	M
CadHeader	M	O	M	M	O	M	M	O	M	M	O	O	M
CadData	M	M	M	M	M	M	M	M	M	M	M	M	M
Step/LayerFeature	M	O	M	M	O	M	M	O	M	M	O	O	M
Step/Datum	M	O	M	M	O	M	M	O	M	M	O	M	M
Step/Profile	M	O	M	M	O	M	M	O	M	M	O	M	M
Step/Package	O	O	M	M	-	-	O	O	M	M	-	-	O
Step/Components	O	O	M	M	-	-	O	O	M	M	-	-	O
Miscellaneous Image Layers	O	O	O	M	O	M	M	-	M	M	-	-	O
CadHeader	M	O	M	M	O	M	M	O	M	M	O	O	M
CadData	M	O	M	M	O	M	M	O	M	M	O	O	M
Step/LayerFeature	M	O	M	M	O	M	M	O	M	M	O	O	M
Design for eXcellence Elements	O	-	O	O	-	O	O	-	O	O	-	O	O
*DfxMeasurementList	O	-	O	M	-	O	M	-	O	M	-	O	M

* DfxMeasurementList is an element child of Ecad/CadData/Step

The correlation between the various descriptions identified in this standard is indicated in Figure 3-1. This shows the relationship of various drawing types within every 2581 file. Many of the drawing types are either electronic versions as unintelligent information (PDF rendering) or they are described as electronic data where the information can be used directly by machines.

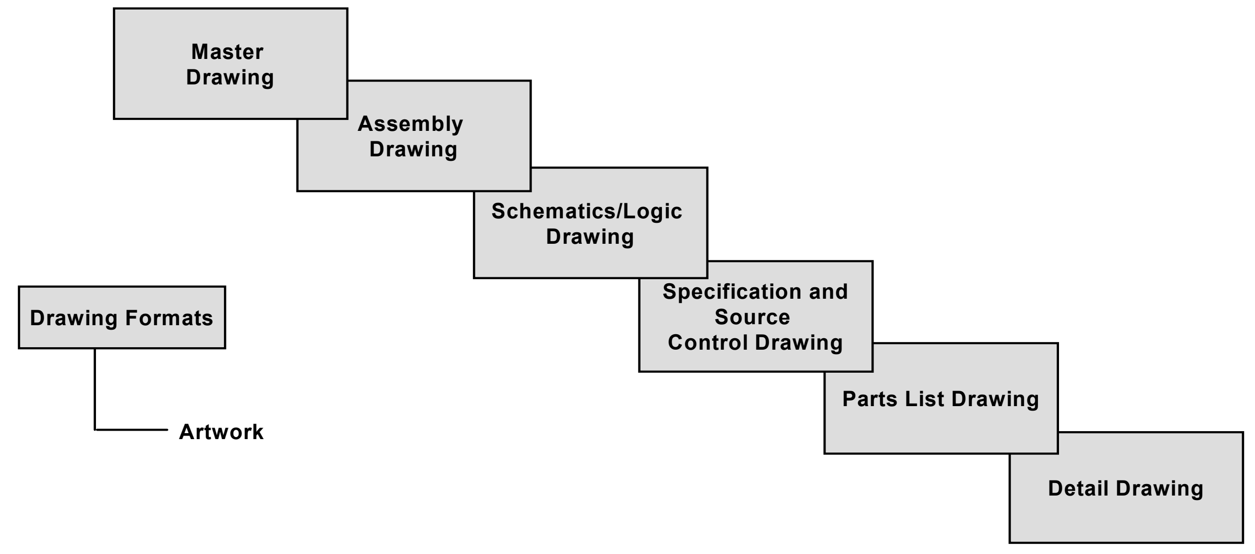


Figure 3-1 Documentation Types

The correlation between various types of drawings is described in the IPC-2610 series of standards. The information in those standards reflects the completeness of the information which follows along the same lines as Table 3-1 in this standard, while the Grade A, B or C defines how much of the documentation is intelligent data and how much is unintelligent.

Figure 3-2 provides an illustration indicating approximate variation in the degree of mixture between electronic and hard copy documentation. Electronic documentation is considered non-intelligent (ready for printing hard copy), while Data is considered as being intelligent (ready for machine usage).

A	B	C
60 - 90 % Hard Copy	10 % - 60% Data	60% - 100% Data
10 - 40% Data	30 % - 80% Electronic Documentation	0% - 40 % Electronic Documentation
	10% - 60% Hard Copy	

Figure 3-2 Documentation Package Grade Requirements

4 GENERAL RULES

The following details reflect the rules used in the 2583 sectional to meet the requirements for design and documentation characteristics data. These rules are intended to meet the needs of the manufacturer to understand the customer requirements.

Wherever necessary, additional requirements have been detailed to reflect precision. The attributes and rules for the data file are described in IPC-2581 are required. Wherever necessary, detailed descriptions or definitions of the entities, attributes or characteristics are described according to the following paragraphs.

4.1 Documentation

Documentation of the design characteristics are used to control work generated from CAD files and sent to members of the supply chain. A basic data model exists as a part of this design intent and how it should be documented. The concepts for describing the documentation or symbology characteristics use the basic structure of the IPC-2581 `Step` configurations. The information is structured by the use of the layer description that is a part of the `CadData`.

In order to meet the requirements of the IPC-2583, the LayerFunction **shall** be one of the enumerated strings defined for Documentation. This concept establishes the focus of the Step context and how it **shall** be used in the data file documenting the board or assembly.

4.2 Content Element

The Content element is a mandatory part of the 2583 file. The information should be consistent with IPC-2581 and the descriptions in IPC-2582. The Content element defines the function of the file, and references the major sections of the product description (e.g., Step, Layer, Bom and Avl). In addition, there are six dictionaries indicated in Content that would contain the pre-described information needed for the file details.

4.3 LogisticHeader Elements

The LogisticHeader information **shall** be in compliance with IPC-2581. The LogisticHeader element consists of information about the owner of the IPC-2581 file. It can be used for configuration management or contact information. The enterprise is also linked to the Bill of Material and the Approved Vendor List (IPC-2588).

The LogisticHeader describes information pertaining to ordering and delivery. This includes the role played by the individual providing ordering and delivery information, the title of the person responsible and the address and particulars of the enterprise.

4.4 History Record Elements

The HistoryRecord descriptions **shall** be in compliance with IPC-2581. The HistoryRecord element consists of changes performed on the file throughout its history. Several attributes are defined as part of the History as well as two elements. These are file revision and change records elements.

4.5 Documentation Layers

The Documentation layer descriptions use the Ecad section of the IPC-2581 standard. The concepts are in compliance with IPC-2581. The Ecad section describes the Computer Aided Design data of the job, including all the graphical description of the layers, component location, panel design, etc. In most cases, the Ecad section is by far the largest body of data inside the 2581 file. To understand how the Ecad section is organized, it is important to be familiar with the Layers and Step elements.

There are times when the owner of the data want to send an abbreviated version of the information to a prospective supplier and would use documentation information in order to provide the supplier with the product characteristics. Portions of the manufacturing data may be used to describe the document so that no new information must be generated. It would therefore be unnecessary to describe assembly methodology if the graphical data could be excised from the cad file to represent an assembly drawing.

Documentation information may take many forms, from simple dictionary descriptions captured in a CAD library to complex schematic drawings that correlate to the final 2581 step/LogicalNet. The intent of all document layers is to provide information useful for evaluation or for archiving as built characteristics.

4.5.1 CadHeader

The CadHeader information **shall** be in accordance with IPC-2581. The CadHeader element is mandatory and **shall** describe the units for all the following documentation information. Units are determined using an enumerated string.

4.5.2 CadData

The CadData description element **shall** be in accordance with IPC-2581. The CadData element is the three-dimensional structure of the design that is retrieved from the CAD system as a group of layers. The information is contained in the Layer element. The Layer element and the related Step

elements **shall** have a mandatory restriction of the single enumerated string for DOCUMENTATION in the `step` "purpose" attribute and the `layer` "context" and "layerFunction" .

4.5.2.1 Layer

As a part of the `Layer` description, the `Layer` element must also be consistent under the `CadData` description. The `Layer` element has several attributes, one of which is `LayerFunction`.

There are four major segments for layers:

MATERIAL for all layer characteristics that represent material descriptions

BOARD for all the layers representing the graphics of the board itself.

PROCESSES for all layer characteristics that represent the board fabrication or the assembly processes.

DOCUMENTATION for all graphical data related to documenting the board or assembly. Recommended documentation layers describe COURTYARD | GRAPH | DRAWING | LANDPATTERN | COMPONENT_TOP | COMPONENT_BOTTOM | OTHER.

A `layerFunction` can take one of 35 discrete characteristics as specified in the XML schema, each representing a different usage for the layer. Some systems may use color coding to distinguish layers by type (Green for solder mask, white for silk screen, etc.).

The side of the layer can take one of 6 discrete values, as specified in the XML schema. This attribute can be stored in the layer but no special action is required by the viewer, as the order of the layers always defines the side.

4.5.3 Step/LayerFeature

All characteristics of the `Step` element **shall** be in compliance with IPC-2581. They **shall** be related to the appropriate `Layer` for DOCUMENTATION. There are two mandatory elements under `Step`. These are the `Datum` element and `Profile` element. The main information for documentation **shall** be identified as part of the `LayerFeature` element.

`LayerFeature` **shall** be in compliance with IPC-2581. The `LayerFeature` element contains all the physical features located on all layers. An individual `LayerFeature` can be thought of as artwork and these two-dimensional descriptions become the main body of the `Step` data. The information is contained in `LayerFeature` elements and includes several different elements, each corresponding to a layer defined earlier in the `Layer` element.

4.5.4 Step/Datum

The `Datum` description **shall** be in compliance with IPC-2581. The `Datum` element of the `Step` schema (`CadData/Step/Datum`) defines the location of the point of origin for the individual `Step` file. The unique name of the `Step` helps to associate the datum between boards and panels or arrays. It is a mandatory part of any DOCUMENTATION description.

4.5.5 Step/Profile

The `Profile` description **shall** be in compliance with IPC-2581. The `Profile` element of the `Step` schema (`CadData/Step/Profile`) defines the exact periphery of the board or assembly and therefore all the characteristics of the `Step` element. It is a mandatory part of any DOCUMENTATION description. The `Profile` element can also be used to define panels, pallet, coupon, and drawing profiles.

4.5.6 Step/Package

The Package descriptions **shall** be in compliance with IPC-2581. The Package element descriptions define the package shape (Outline), library descriptions including land patterns, silk screen information, assembly drawing details, and pin identification. The Package element defines all the physical description of all the packages used by the Component element inside the Step.

4.5.7 Step/Component

The Component descriptions **shall** be in compliance with IPC-2581. The component element descriptions define the individual component locations needed for the assembly drawing. The component element defines all the relationships to the package physical descriptions used by the Component element inside the Step.

4.6 Miscellaneous Step Descriptions

Miscellaneous images of the design characteristics are used to enhance CAD data file and may be sent to members of the supply chain. A basic data model can be used as a part of design intent and uses the miscellaneous images to define the requirements. The concepts for describing the symbology characteristics use the basic structure of the IPC-2581 Step configurations. The information is structured by the use of the layer description that is a part of the CadData.

In order to meet the requirements of IPC-2583, the LayerFunction **shall** be identified as DOCUMENTATION and the enumerated string corresponding to miscellaneous layers should be OTHER. This concept establishes the focus of the Step and how it **shall** be used in the data file describing the board, board panel, assembly, etc. whenever the purpose of the Step is identified as MISCELLANEOUS with the layerFunction being OTHER.

4.6.1 CadHeader

The CadHeader is not required if already defined for DOCUMENTATION. If only MISCELLANEOUS layers are described the CadHeader information is required and **shall** be in accordance with IPC-2581.and as described in paragraph 4.5.1.

4.6.2 CadData

The CadData is not required if already defined for Documentation. If only MISCELLANEOUS layers are described the CadData information is required and **shall** be in accordance with IPC-2581.and as described in paragraph 4.5.2.

4.6.3 Step/LayerFeature

All characteristics of the Step element **shall** be in compliance with IPC-2581.Although a different usage then normal documentation the layerFeature describes the full characteristics of miscellaneous layers. It is not required if document layers already exist.

LayerFeature **shall** be in compliance with IPC-2581. The LayerFeature element contains all the physical features located on all layers. An individual LayerFeature can be thought of as artwork and these two-dimensional descriptions become the main body of the Step data. The information is contained in LayerFeature elements and includes several different elements, each corresponding to a layer defined earlier in the Layer element.

4.7 Design for eXcellence Elements

The Design for eXcellence analysis (DfX) represents the communication between the supplier and the owner of the data. This documentation provides not only a history of manufacturing difficulty but should be reviewed by the file owner before re-order additional parts that carry the same yield deficits. Some times the information is generated by a CAD tool however most of the time it is developed by the CAM tool used to perform the manufacturing enhancement and process characterization. The contractual

requirements should specify the relationship between owner and supplier and how this documentation data should be used.

The Design for eXcellence description **shall** be in compliance with IPC-2581. Many design and manufacturing tools have the ability to analyze the details of a data file and make a determination as to whether all the design rules have been met or if the parts are manufacturable within the capability of the board fabricator or assembler. The results of these analyses need to be retained so that future users of the data contained in the IPC-2581 file are aware of the improvements or risks which are apparent within the manufacturing domain.

4.7.1 DfxMeasurementList

The `DfxMeasurementList` element consists of a variety of measurements identified as `DfxMeasurement`. Each of these lists is identified separately so that the design for manufacturing analysis can be grouped according to their particular characteristic. The granularity of this grouping is dependent on the desire of the designer, fabricator, or assembler to capture the details of the Dfx analysis. The concepts are in compliance with IPC-2581.

4.7.1.1 DfxMeasurement

The `DfxMeasurement` element **shall** be in compliance with IPC-2581. The `DfxMeasurement` element consists of various measurements that are related to a particular characteristic of the product. The DfxMeasurement's are made on individual layers or product to determine design for manufacturing characteristics.

5 MODELING

The data files of the 2583 may be mapped to a UML data model. Data models are developed to ensure that complete mapping is capable between the information provided within the 2583 characteristics. The correlation is provided in the activity models shown in IPC- 2589.

All data activities are based on activity models as defined in IPC-2589. The activity models covered by CAD and CAM include the engineering, design, administrative, fabrication, assembly and testing characteristics. Each of these sections are intended to be detailed into various levels of activity much like layers of information needed to perform a particular manufacturing process.

6 DOCUMENTATION EXAMPLES

Data can be extracted from 2583 files to produce various formats that are commonly used in the electronics industry. The types of reformatting can be used for electronic data transfer to tools or to facilitate inspection and human interpretation of text and/or graphic rendering. Note that no extraction tools are included in the IPC-2580 standards however several tools have been developed that are downloadable from the IPC website.

The creation of data base manipulation tools is left to the industry as the need arises. Several examples have been provided and are shown in Figures 6-1 and 6-2. They can be represented as image files in a PDF format or use some other graphic software tool in order to provide the documented information.

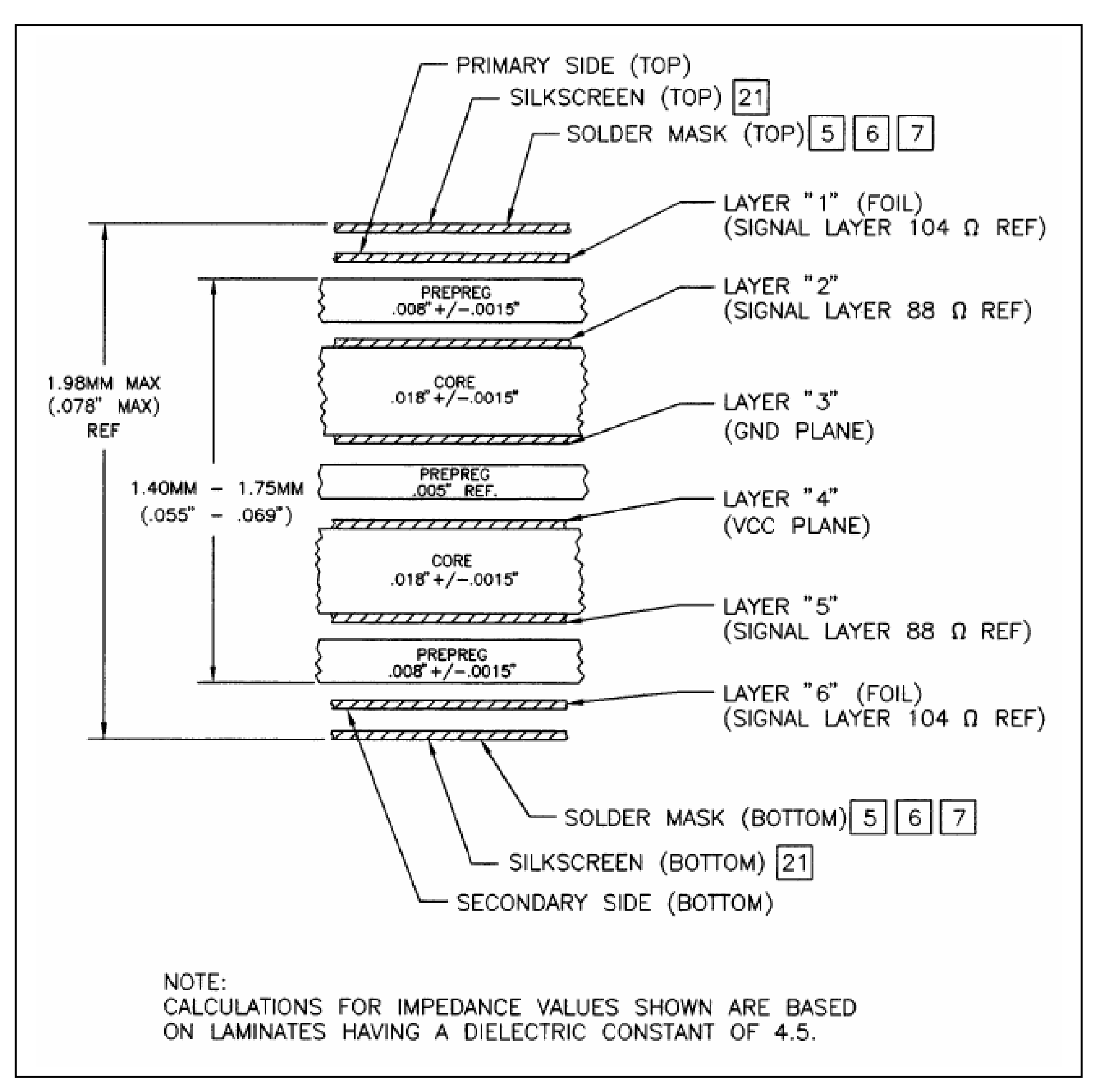


Figure 6-1 Board Cross Section - Six Layer Construction

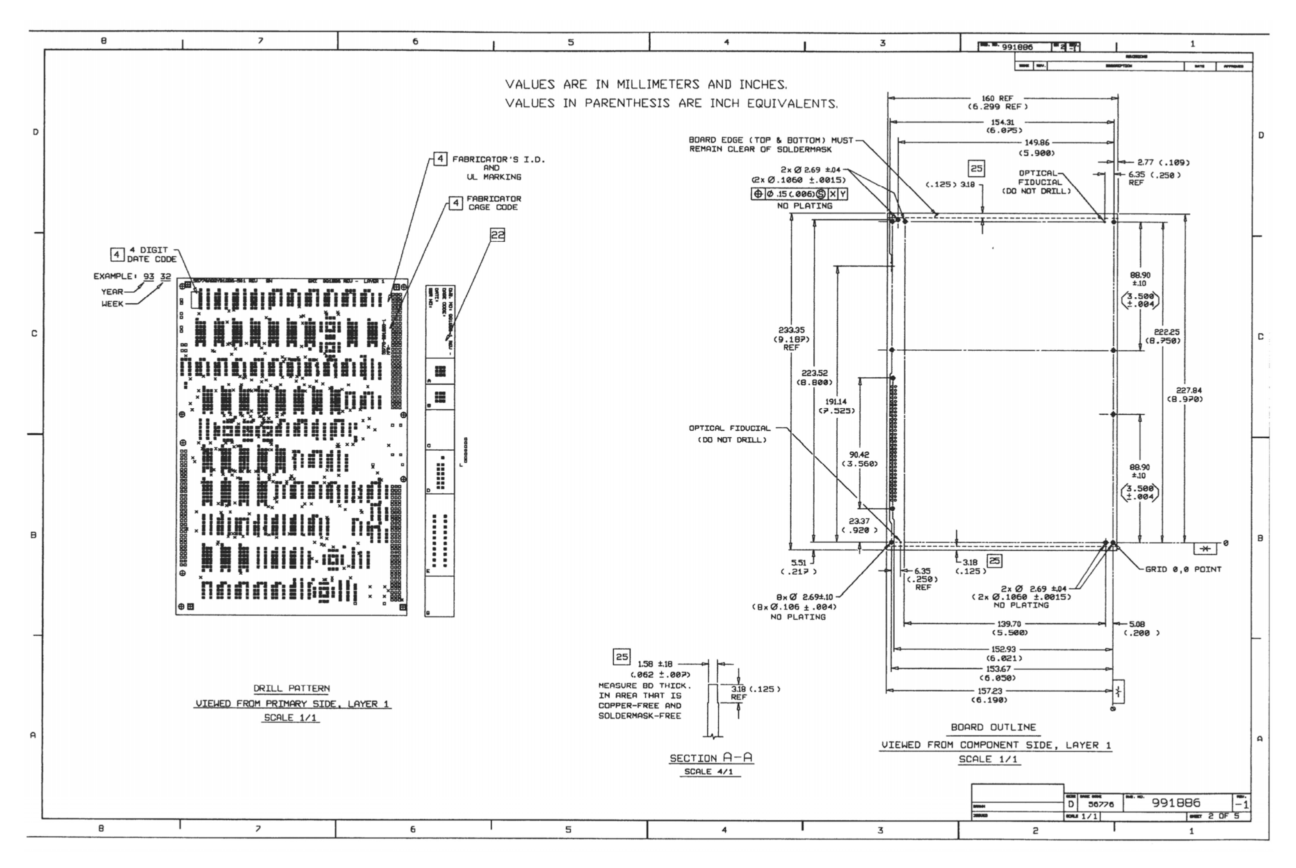


Figure 6-2 Typical Multilayer Master Drawing,

7 REFERENCE INFORMATION

The following sections define reference documents that are useful in clarifying the products or process of the industry or provide additional insight into the subject of data modeling or released information models.

7.1 IPC

IPC-2221 *Design Standard for Rigid Printed Boards and Rigid Printed Board Assemblies*

IPC-2615 *Printed Board Dimensions and Tolerances*

IPC-D-310 *Guidelines for Artwork Generation and Measurement Techniques for Printed Circuits*

IPC-D-325 *Documentation Requirements for Printed Boards, Assemblies and Support Drawings*

IPC-2611 *Generic Requirements for Electronic Product Documentation*

7.2 American National Standards Institute

ANSI X3/TR-1-77 *American National Dictionary for Information Processing*

ANSI X3.12 *Subroutine Record Format Standardization*

ANSI Y14.5 *Dimensioning and Tolerancing for Engineering Drawing*

ANSI Y32.1 *Logic Diagram Standards*

ANSI Y32.16 *Electrical and Electrical Reference Designators*

ANSI Z210.1 *Metric Practice Guide (ASTM 380-72)*

7.3 Department of Defense

DoD-STD-100 *Engineering Drawings*

7.4 Electronic Industries Association

EDIF 4 0 0 *Electronic Data Interchange Format*

7.5 International Electrotechnical Commission (IEC)

IEC 61182-2 *Generic requirements for printed board and printed board assembly XML descriptions*

7.6 International Organization for Standards (ISO)

ISO STEP Documentation

AP210 *Electronic Printed Circuit Assembly: Drawings and Manufacturing*

AP211 *Electronic PC Assembly, Test Diagnostics & Remanufacture*

AP221 *Process Plant Functional Data & Schematic Representation*

APPENDIX A

DRAWING METHOD SCHEMA

IPC-2581
Content Elements in Accordance with IPC-2582
Logistic Header Elements in Accordance with IPC-2582
History Record Elements in Accordance with IPC-2582

Documentation Layers Elements
IPC-2581/Ecad
IPC-2581/Ecad/CadHeader
IPC-2581/Ecad/CadHeader/Spec
IPC-2581/Ecad/CadHeader/Spec/Xform
IPC-2581/Ecad/CadHeader/Spec/Location
IPC-2581/Ecad/CadHeader/Spec/Outline
IPC-2581/Ecad/CadHeader/Spec/Outline/Polygon
IPC-2581/Ecad/CadHeader/Spec/Outline/Polygon/PolyBegin
IPC-2581/Ecad/CadHeader/Spec/Outline/Polygon/PolyStepCurve
IPC-2581/Ecad/CadHeader/Spec/Outline/Polygon/PolyStepSegment
IPC-2581/Ecad/CadHeader/Spec/Outline/LineDesc
IPC-2581/Ecad/CadHeader/Spec/Outline/LineDescRef
IPC-2581/Ecad/CadHeader/Spec/Modification
IPC-2581/Ecad/CadHeader/SurfaceFinish
IPC-2581/Ecad/CadHeader/SurfaceFinish/FinishType
IPC-2581/Ecad/CadHeader/SurfaceFinish/FinishType/Color
IPC-2581/Ecad/CadHeader/SurfaceFinish/FinishType/ColorRef
IPC-2581/Ecad/CadHeader/ChangeRec
IPC-2581/Ecad/CadHeader/ChangeRec/Approval
IPC-2581/Ecad/CadData
IPC-2581/Ecad/CadData/Layer
IPC-2581/Ecad/CadData/Layer/Span
IPC-2581/Ecad/CadData/Layer/DrillTool
IPC-2581/Ecad/CadData/Stackup
IPC-2581/Ecad/CadData/Stackup/StackupGroup
IPC-2581/Ecad/CadData/Stackup/StackupGroup/StackupLayer
IPC-2581/Ecad/CadData/Stackup/StackupImpedance
IPC-2581/Ecad/CadData/Stackup/StackupImpedance/Xform
IPC-2581/Ecad/CadData/Stackup/StackupImpedance/Location
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IPC-2581/Ecad/CadData/Step/Route/LayerFeature/Set/IntegerAttribute

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IPC-2581/Ecad/CadData/Step/Route/LayerFeature/Set/GlobalFiducial/Xform
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IPC-2581/Ecad/CadData/Step/Route/LayerFeature/Set/GlobalFiducial/Butterfly

IPC-2581/Ecad/CadData/Step/Route/LayerFeature/Set/GlobalFiducial/Circle
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IPC-2581/Ecad/CadData/Step/Route/LayerFeature/Set/LocalFiducial/Circle
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IPC-2581/Ecad/CadData/Step/Route/LayerFeature/Set/LocalFiducial/Contour/Cutout/PolyBegin
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IPC-2581/Ecad/CadData/Step/Route/LayerFeature/Set/Features/RectCenter
IPC-2581/Ecad/CadData/Step/Route/LayerFeature/Set/Features/RectCham
IPC-2581/Ecad/CadData/Step/Route/LayerFeature/Set/Features/RectCorner
IPC-2581/Ecad/CadData/Step/Route/LayerFeature/Set/Features/RectRound

IPC-2581/Ecad/CadData/Step/Route/LayerFeature/Set/Features/Thermal
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IPC-2581/Ecad/CadData/Step/Route/LayerFeature/Set/Features/Text/Xform
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IPC-2581/Ecad/CadData/Step/Route/LayerFeature/Set/Features/Text/FontRef
IPC-2581/Ecad/CadData/Step/Route/LayerFeature/Set/Features/Text/Color
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IPC-2581/Ecad/CadData/Step/Route/LayerFeature/Set/Features/UserPrimitiveRef
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IPC-2581/Ecad/CadData/Step/Profile
IPC-2581/Ecad/CadData/Step/Profile/Polygon
IPC-2581/Ecad/CadData/Step/Profile/Polygon/PolyBegin
IPC-2581/Ecad/CadData/Step/Profile/Polygon/PolyStepCurve
IPC-2581/Ecad/CadData/Step/Profile/Polygon/PolyStepSegment
IPC-2581/Ecad/CadData/Step/Profile/Cutout
IPC-2581/Ecad/CadData/Step/Profile/Cutout/PolyBegin
IPC-2581/Ecad/CadData/Step/Profile/Cutout/PolyStepCurve
IPC-2581/Ecad/CadData/Step/Profile/Cutout/PolyStepSegment
IPC-2581/Ecad/CadData/Step/StepRepeat
IPC-2581/Ecad/CadData/Step/Package
IPC-2581/Ecad/CadData/Step/Package/Outline
IPC-2581/Ecad/CadData/Step/Package/Outline/Polygon
IPC-2581/Ecad/CadData/Step/Package/Outline/Polygon/PolyBegin
IPC-2581/Ecad/CadData/Step/Package/Outline/Polygon/PolyStepCurve
IPC-2581/Ecad/CadData/Step/Package/Outline/Polygon/PolyStepSegment
IPC-2581/Ecad/CadData/Step/Package/Outline/LineDesc
IPC-2581/Ecad/CadData/Step/Package/Outline/LineDescRef
IPC-2581/Ecad/CadData/Step/Package/LandPattern
IPC-2581/Ecad/CadData/Step/Package/LandPattern/Pad
IPC-2581/Ecad/CadData/Step/Package/LandPattern/Pad/Xform
IPC-2581/Ecad/CadData/Step/Package/LandPattern/Pad/Location
IPC-2581/Ecad/CadData/Step/Package/LandPattern/Pad/Butterfly
IPC-2581/Ecad/CadData/Step/Package/LandPattern/Pad/Circle
IPC-2581/Ecad/CadData/Step/Package/LandPattern/Pad/Contour
IPC-2581/Ecad/CadData/Step/Package/LandPattern/Pad/Contour/Polygon
IPC-2581/Ecad/CadData/Step/Package/LandPattern/Pad/Contour/Polygon/PolyBegin
IPC-2581/Ecad/CadData/Step/Package/LandPattern/Pad/Contour/Polygon/PolyStepCurve

IPC-2581/Ecad/CadData/Step/Package/LandPattern/Pad/Contour/Polygon/PolyStepSegment
IPC-2581/Ecad/CadData/Step/Package/LandPattern/Pad/Contour/Cutout
IPC-2581/Ecad/CadData/Step/Package/LandPattern/Pad/Contour/Cutout/PolyBegin
IPC-2581/Ecad/CadData/Step/Package/LandPattern/Pad/Contour/Cutout/PolyStepCurve
IPC-2581/Ecad/CadData/Step/Package/LandPattern/Pad/Contour/Cutout/PolyStepSegment
IPC-2581/Ecad/CadData/Step/Package/LandPattern/Pad/Diamond
IPC-2581/Ecad/CadData/Step/Package/LandPattern/Pad/Donut
IPC-2581/Ecad/CadData/Step/Package/LandPattern/Pad/Ellipse
IPC-2581/Ecad/CadData/Step/Package/LandPattern/Pad/Hexagon
IPC-2581/Ecad/CadData/Step/Package/LandPattern/Pad/Moire
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IPC-2581/Ecad/CadData/Step/Package/LandPattern/Target/Xform
IPC-2581/Ecad/CadData/Step/Package/LandPattern/Target/Location
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IPC-2581/Ecad/CadData/Step/Package/LandPattern/Target/Contour/Polygon/PolyStepCurve
IPC-2581/Ecad/CadData/Step/Package/LandPattern/Target/Contour/Polygon/PolyStepSegment
IPC-2581/Ecad/CadData/Step/Package/LandPattern/Target/Contour/Cutout
IPC-2581/Ecad/CadData/Step/Package/LandPattern/Target/Contour/Cutout/PolyBegin
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IPC-2581/Ecad/CadData/Step/Package/LandPattern/Target/RectCham
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IPC-2581/Ecad/CadData/Step/Package/SilkScreen/Target/Location
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IPC-2581/Ecad/CadData/Step/Package/SilkScreen/Target/Contour/Polygon/PolyStepSegment
IPC-2581/Ecad/CadData/Step/Package/SilkScreen/Target/Contour/Cutout
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IPC-2581/Ecad/CadData/Step/Package/SilkScreen/Target/RectCham
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IPC-2581/Ecad/CadData/Step/Package/AssemblyDrawing/Target/Oval
IPC-2581/Ecad/CadData/Step/Package/AssemblyDrawing/Target/RectCenter
IPC-2581/Ecad/CadData/Step/Package/AssemblyDrawing/Target/RectCham

IPC-2581/Ecad/CadData/Step/Package/AssemblyDrawing/Target/RectCorner
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IPC-2581/Ecad/CadData/Step/Component/NonstandardAttribute
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IPC-2581/Ecad/CadData/Step/LayerFeature/Set/Pad/Xform
IPC-2581/Ecad/CadData/Step/LayerFeature/Set/Pad/Location

IPC-2581/Ecad/CadData/Step/LayerFeature/Set/Pad/Butterfly
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IPC-2581/Ecad/CadData/Step/LayerFeature/Set/Pad/Contour/Cutout/PolyBegin
IPC-2581/Ecad/CadData/Step/LayerFeature/Set/Pad/Contour/Cutout/PolyStepCurve
IPC-2581/Ecad/CadData/Step/LayerFeature/Set/Pad/Contour/Cutout/PolyStepSegment
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IPC-2581/Ecad/CadData/Step/LayerFeature/Set/Pad/Donut
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IPC-2581/Ecad/CadData/Step/LayerFeature/Set/Pad/Hexagon
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IPC-2581/Ecad/CadData/Step/LayerFeature/Set/Pad/Octagon
IPC-2581/Ecad/CadData/Step/LayerFeature/Set/Pad/Oval
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IPC-2581/Ecad/CadData/Step/LayerFeature/Set/BadBoardMark/Circle
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IPC-2581/Ecad/CadData/Step/LayerFeature/Set/BadBoardMark/Ellipse
IPC-2581/Ecad/CadData/Step/LayerFeature/Set/BadBoardMark/Hexagon
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IPC-2581/Ecad/CadData/Step/LayerFeature/Set/GlobalFiducial/Xform
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IPC-2581/Ecad/CadData/Step/LayerFeature/Set/GlobalFiducial/Contour/Polygon/PolyStepCurve
IPC-2581/Ecad/CadData/Step/LayerFeature/Set/GlobalFiducial/Contour/Polygon/PolyStepSegment

IPC-2581/Ecad/CadData/Step/LayerFeature/Set/GlobalFiducial/Contour/Cutout
IPC-2581/Ecad/CadData/Step/LayerFeature/Set/GlobalFiducial/Contour/Cutout/PolyBegin
IPC-2581/Ecad/CadData/Step/LayerFeature/Set/GlobalFiducial/Contour/Cutout/PolyStepCurve
IPC-2581/Ecad/CadData/Step/LayerFeature/Set/GlobalFiducial/Contour/Cutout/PolyStepSegment
IPC-2581/Ecad/CadData/Step/LayerFeature/Set/GlobalFiducial/Diamond
IPC-2581/Ecad/CadData/Step/LayerFeature/Set/GlobalFiducial/Donut
IPC-2581/Ecad/CadData/Step/LayerFeature/Set/GlobalFiducial/Ellipse
IPC-2581/Ecad/CadData/Step/LayerFeature/Set/GlobalFiducial/Hexagon
IPC-2581/Ecad/CadData/Step/LayerFeature/Set/GlobalFiducial/Moire
IPC-2581/Ecad/CadData/Step/LayerFeature/Set/GlobalFiducial/Octagon
IPC-2581/Ecad/CadData/Step/LayerFeature/Set/GlobalFiducial/Oval
IPC-2581/Ecad/CadData/Step/LayerFeature/Set/GlobalFiducial/RectCenter
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IPC-2581/Ecad/CadData/Step/LayerFeature/Set/GlobalFiducial/RectCorner
IPC-2581/Ecad/CadData/Step/LayerFeature/Set/GlobalFiducial/RectRound
IPC-2581/Ecad/CadData/Step/LayerFeature/Set/GlobalFiducial/Thermal
IPC-2581/Ecad/CadData/Step/LayerFeature/Set/GlobalFiducial/Triangle
IPC-2581/Ecad/CadData/Step/LayerFeature/Set/GlobalFiducial/StandardPrimitiveRef
IPC-2581/Ecad/CadData/Step/LayerFeature/Set/GoodPanelMark
IPC-2581/Ecad/CadData/Step/LayerFeature/Set/GoodPanelMark/Xform
IPC-2581/Ecad/CadData/Step/LayerFeature/Set/GoodPanelMark/Location
IPC-2581/Ecad/CadData/Step/LayerFeature/Set/GoodPanelMark/Butterfly
IPC-2581/Ecad/CadData/Step/LayerFeature/Set/GoodPanelMark/Circle
IPC-2581/Ecad/CadData/Step/LayerFeature/Set/GoodPanelMark/Contour
IPC-2581/Ecad/CadData/Step/LayerFeature/Set/GoodPanelMark/Contour/Polygon
IPC-2581/Ecad/CadData/Step/LayerFeature/Set/GoodPanelMark/Contour/Polygon/PolyBegin
IPC-2581/Ecad/CadData/Step/LayerFeature/Set/GoodPanelMark/Contour/Polygon/PolyStepCurve
IPC-2581/Ecad/CadData/Step/LayerFeature/Set/GoodPanelMark/Contour/Polygon/PolyStepSegment
IPC-2581/Ecad/CadData/Step/LayerFeature/Set/GoodPanelMark/Contour/Cutout
IPC-2581/Ecad/CadData/Step/LayerFeature/Set/GoodPanelMark/Contour/Cutout/PolyBegin
IPC-2581/Ecad/CadData/Step/LayerFeature/Set/GoodPanelMark/Contour/Cutout/PolyStepCurve
IPC-2581/Ecad/CadData/Step/LayerFeature/Set/GoodPanelMark/Contour/Cutout/PolyStepSegment
IPC-2581/Ecad/CadData/Step/LayerFeature/Set/GoodPanelMark/Diamond
IPC-2581/Ecad/CadData/Step/LayerFeature/Set/GoodPanelMark/Donut
IPC-2581/Ecad/CadData/Step/LayerFeature/Set/GoodPanelMark/Ellipse
IPC-2581/Ecad/CadData/Step/LayerFeature/Set/GoodPanelMark/Hexagon
IPC-2581/Ecad/CadData/Step/LayerFeature/Set/GoodPanelMark/Moire
IPC-2581/Ecad/CadData/Step/LayerFeature/Set/GoodPanelMark/Octagon
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IPC-2581/Ecad/CadData/Step/LayerFeature/Set/GoodPanelMark/RectRound
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IPC-2581/Ecad/CadData/Step/LayerFeature/Set/LocalFiducial/Xform
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IPC-2581/Ecad/CadData/Step/LayerFeature/Set/LocalFiducial/Butterfly
IPC-2581/Ecad/CadData/Step/LayerFeature/Set/LocalFiducial/Circle
IPC-2581/Ecad/CadData/Step/LayerFeature/Set/LocalFiducial/Contour
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IPC-2581/Ecad/CadData/Step/LayerFeature/Set/LocalFiducial/Diamond
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IPC-2581/Ecad/CadData/Step/LayerFeature/Set/LineDescRef

Design for eXcellence (DFX) Elements
IPC-2581/Ecad/CadData/Step/DfxMeasurementList
IPC-2581/Ecad/CadData/Step/DfxMeasurementList/DfxMeasurement
IPC-2581/Ecad/CadData/Step/DfxMeasurementList/DfxMeasurement/Arc
IPC-2581/Ecad/CadData/Step/DfxMeasurementList/DfxMeasurement/Arc/LineDesc
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IPC-2581/Ecad/CadData/Step/DfxMeasurementList/DfxMeasurement/Line/LineDescRef
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